

## A Case Study on Course Outcome & Program Outcome Mapping Levels Based on Competency & Performance Indicators.

<sup>1</sup>Ansar A. Mulla, <sup>2</sup>Hanmant S. Jadhav, <sup>1</sup>Abhijit P. Shah

<sup>1</sup>Mechanical Engineering Department, Rajarambapu Institute of Technology Rajaramnagar. SUK.

<sup>2</sup>Civil Engineering Department, Rajarambapu Institute of Technology Rajaramnagar. SUK.

**Abstract**— This Paper gives an insight into an essential part of practicing outcome-based education (OBE). One of the crucial parts of OBE is measuring the quality and quantity of Program learning skills that student has acquired through various assessments. Course Outcome attainment heads up the learning in a specific course. However, the Program Outcome (PO) attainment needs the relation of Course Outcome & Program Outcome (CO-PO), i.e., mapping levels for calculations. The author has demonstrated the CO-PO mapping level underpinning the competency and Performance Indicators. The methodology for CO-PO Mapping has been shown in the Paper. A review on Mapping has been taken on an online feedback survey and found that mentoring is required in the CO-PO mapping level and interpreting it at hard-shell. CO-PO Mapping for a course has been demonstrated w.r.t. the process followed, and calculations to the end have been explained. There is an opportunity to take PO assessment methods further with mapping levels concentrating on defining competencies and Performance Indicators.

**Keywords**—Course Outcome (CO), Program Outcome (PO), CO-PO Mapping, Competency, Performance Indicators OBE.

### I. INTRODUCTION

THE teaching-learning process is the heart of any educational system at a level and takes the stakes to their wisdom. Outcome-based education has emphasized the same, and the focus of learners' learning is at the center of the teacher's teaching.

In outcome-based education, the education focuses on learners' skill development at Cognitive, Psychomotor, and Attitude levels. The above skill level varies with education streams and level of education from school to higher education colleges & universities. (Spady, 1993) While implementing outcome-based education ensures a certain amount or level of measurement quality has been imparted to the learner.

Measuring of quality of education imparted to students leads to the assessment and evaluation of learning by students in examinations (Yuet Yen Wong, 2015). AICTE has been defined and guided through Examination reforms and Policies, which also support better assessment in studies, measuring outcomes at the course and program levels. Model question papers that will help in the evaluation program skills incorporated by a student.

Exam Reforms (REFORMS, 2018) this reform has guided the Assessment strategy for outcome-based Education (OBE). It suggested a two-step process bringing clarity to PO, Mapping

PO to examinations/examination tools, what skills competencies curriculum of a program develops, and performance indicators through which can assess these competencies. Examination tools that evaluate higher-order abilities and professional skills are also demonstrated (Dr. A. Kavitha, 2018).

It becomes abstruse to justify the CO-PO mapping level defined by the course teacher (Jayasree & Durga, 2018). There becomes a necessity for scientific or any statistical relevance that will rigid the CO-PO mapping level (Reddy, Karuppiiah, Asif, & Ravivarman, 2021). The Mapping of the CO-PO level concerning Competency and Performance Indicators makes it a cakewalk for the course in charge to demonstrate for a third person.

Competencies are simplified statements that focus on different abilities to be attained by the learners. These are Domain-specific and can be used to assess the student's learning ability.

Competencies are statements that showcase what students demonstrate concerning PO from the program curriculum. Each PO and Program Specific Outcome (PSO) can be implied by an ability that is needed to be shown by the program student/learner. This demonstrative ability requires assessment procedures, creating a shared understanding that students want to achieve through their respective programs. A program needs to identify what competencies and various skills can be built in students concerning each PO, these competencies will give an idea for performing indicators through which we can measure these competencies, and subsequently, the quality of PO can be measured.

Performance Indicators (PI) - Measuring tool in Assessment, Performance Indicators are the statements used to evaluate various competencies; they can be designed to find the appropriate level of Competency of each indicator so that instructors can target and students can achieve the acceptable level of proficiency

A feedback survey has been taken, and an understanding of CO-PO mapping levels and how mapping levels are justified is analyzed. The next section describes the feedback survey followed by the methodology proposed and the tool used at the Institute of the same.

#### A. Responses of faculties involved in OBE and teaching – Learning Practices

Online feedback is taken, and responses have been analyzed for the ten questions stated below, responses for understanding

CO-PO Mapping concerning competency and performance Indicators. Questionnaires as,

1. At what level do you teach?

*Response - Diploma/Polytechnic,  
Degree,  
PG & above,  
Other...;*

2. Is any of your Institute Program NBA Accredited?

*Response - Yes, No,*

3. Will you be able to justify your CO-PO Mapping with the same justification (words/Sentences) if asked after a few days? *Response - Yes, No*

4. On What basis do you map the CO of your Course with your Program's PO/Program Specific Outcome (PSO)?

*Response - Course content,  
On self Judgement/Understanding,  
Competency,  
Performance Indicator,  
Competency & Performance Indicator,  
Other...;*

1. What if CO-PO mapping Justification is rigid at your end, and you can showcase it to anyone for its justification at any number of times? Question Type, *Response - It will be helpful,  
It will not be beneficial;*

2. Do you know any tool that helps in CO-PO Mapping? *Response - Yes, No;*

3. Does your Program do CO-PO Mapping based on Competency and Performance Indicators?

*Response - Yes, No;*

4. Is your Question Paper set, As Questions mapping to the Performance Indicator that it will assess for evaluation of Competency in respective Program Outcomes?

*Response - Yes, No.*

9. You can learn more through the Examination Reform Policy given by AICTE. *Response – For information*

10. Anything you would like to suggest in CO-PO Mapping & PO Assessment?

*Response – Short Answer*

Responses collected and analyzed, hundred plus responses have been collected; the responses are as below,

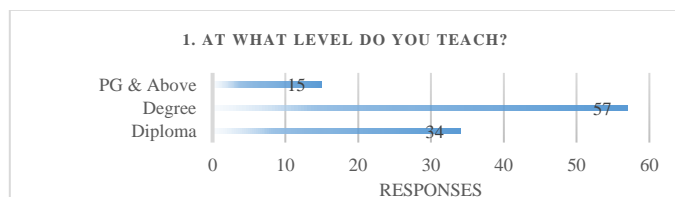


Figure 1: Responses collected from survey w.r.t. question number 1.

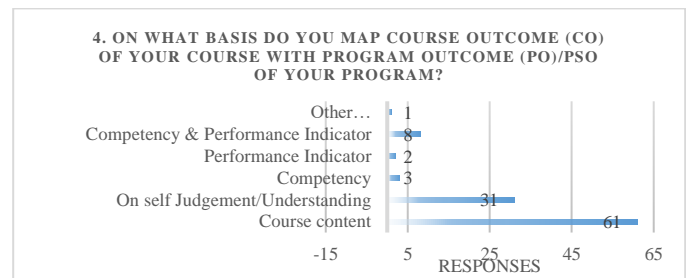


Figure 2: Responses collected from survey w.r.t. question number 4.

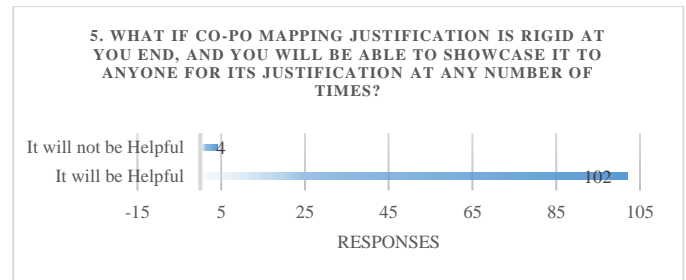


Figure 3: Responses collected from survey w.r.t. question number 5.

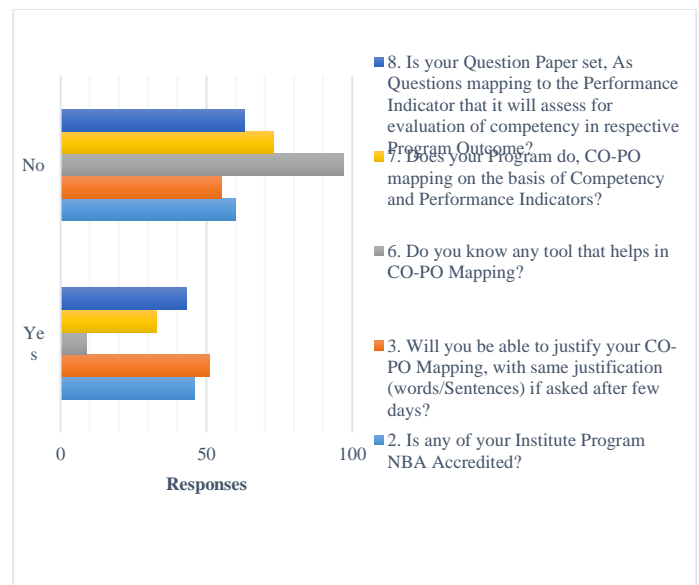


Figure 4: Responses collected from survey w.r.t. question number 2,3,6,7,8.

More than a hundred responses were collected and projected here to date, yet responses are being received as the survey form is spread without local boundary limitations. From the received responses, Figure 1 presents a response to Question Number 1 – many responses are degree and Diploma polytechnic level received. Figure 2 presents a response to question Number 4 – course mapping is done on the content understanding of the charge course, and no scientific base is used; however, very few programs use competency and performance indicators as a base for CO-PO Mapping. There is also judgmental justification given for CO-PO Mapping. Figure 3 presents a response to question Number 5 –most favoring a scientific, statistical method that will justify CO-PO mapping levels. Figure 4 presents a response to questions Number 2,3,6,7,8 – these responses were received in Yes-No format; from the responses, it can be seen that approximately 50% of programs have not yet

NBA accredited for responding; they may be in the process of it, and also started outcome-based education implementation in teaching-learning processes. The question papers set for the in-semester examinations are not showcasing the Competency that it will build and the distribution of skill levels that could be done by CO-PO Mapping based on competency and Performance Indicators.

The overall analysis from the survey tells that there are directions/ mentoring required for mapping CO-PO levels. CO-PO mapping levels are Level 3 = highly mapped, Level 2 = moderately mapped, Level 1 = low mapping & - as no mapping. When justifying the mapping level, a course In charge has no rigid justification. The justification is given with words like more, maximum, moderate, and less content contributes, so the Mapping is high, moderate, or low. There are affiliated institutes and their faculties unaware of the competencies that the curriculum will develop, which links with the PO statements. Even if the charge course is asked for justification for the mapping level, there will be some different answers at that time. This led to a statistical and scientific mechanism to justify CO-PO mapping levels w.r.t. competency and performance indicators. In further sections, the author has demonstrated the scientific method of mapping course outcomes to the program outcomes.

## II. METHODOLOGY FOLLOWED

Implementation of the Competency and Performance Indicators based on CO-PO Mapping for Structuring and quality of assessments is proposed in this section.

From the academic curriculum, syllabus course content is incarnated, and this Program builds the competencies that students can demonstrate, showcasing the PO skills. Each PO to be assessed is defined with these competencies, and each Competency to be demonstrable is assessed by performing indicators. Sample competencies and performance indicators are given in AICTE exam Reforms for a few of the programs. The same could be referred to and developed in our programs concerning education levels.

At our Institute Rajarambapu Institute of Technology for the Diploma Programs, competencies and performance Indicators have been defined for each, and the CO-PO is done respectively.

### 1 The Structure Competencies and Performance Indicators are defined at the respective Program.

The AICTE Examination reform policy gives the structuring guideline for two-step CO-PO mapping; it gives clarity to give scientific relation to evaluating the PO with assessment tools through the performance indicators building competency to

skill up program outcome.

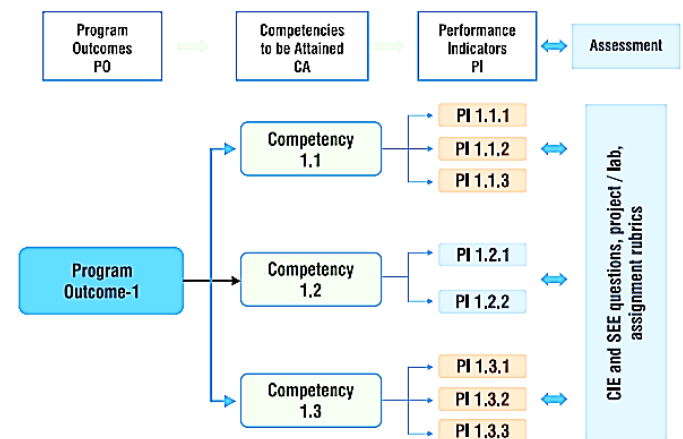


Figure 5 Structure – Connecting PO to Assessment through Competencies and Performance Indicators PI. (REFORMS, 2018)

### 2 Methodology of CO-PO mapping levels

The methodology of Implementation of CO-PO based on Competency and performance at our Program and Institute is defined in this section,

Figure 5 CO-PO Mapping w.r.t. Competency & Performance Indicators Process Flow Chart shows the process and approving the CO-PO Mapping.

At the Program/Department in the Board of Studies (BOS) or Program Assessment and Quality Improvement Committee (PAQIC), or any Body or Committee that ruminate in the academics of the Program defines competencies that learner can demonstrate from the program curriculum, these competencies are lined with respective PO. For the respective competencies to be assessed, performance indicators are defined, and based on these Performance indicators; the CO-PO is mapped.

Course in charge maps CO statements with PO w.r.t. Competency & PI for his respective course. This Mapping as a draft copy (Resource Material, 2022) is proposed in the form of the approving authority Department Advisory Board DAB/ Board of Studies; if the approval committee approves this proposed Mapping, it is considered as it is. If the committee gives some modifications or suggestions, then the course in charge rechecks mapping and do modification as per the suggestion received from the committee. Committee approves now this modified CO-PO Mapping. This approved copy (Resource Material, 2022) will be submitted to the Department and considered for further attainment. This Mapping will be used to evaluate PO attainment through CO attainment. The CO- PO mapping justification is represented by performance indicators that substrates competency and program outcome (Resource Material, 2022).

### Submissions at Department by course In charge,

In the Figure 6 CO-PO Mapping w.r.t. Competency & Performance Indicators (Process Flow Chart)

The submission of the CO-PO mapping process is shown, The process, At first, the Competencies and Performance Indicators (PI) have been defined by the Department Advisory board (DAB) or Board of studies,

1. These competencies and PI have been used to map CO with PO & PSO based on the Competency that the program curriculum will build in learners by each course in charge.

2. The CO-PO mapped at the initial level by the course in charge is proposed in front of DAB as Draft Copy - CO-PO&PSO Mapping w.r.t. Competency & Performance Indicators.
3. With implementing reviewees' suggestions/ modifications, the charge course prepares Approved Copy and gets approval of the same in DAB (Approval Authority) - CO-PO&PSO Mapping w.r.t. Competency & Performance Indicators.
4. Justification of CO-PO&PSO Mapping level is shown by CO mapped to the respective Performance Indicator- in line with Competency.
5. The Draft and Approved copy format are available as a resource file in supporting document Downloadable (Resource Material, 2022) as appendix I & II, While the CO-PO&PSO Mapping for all PO&PSO is as appendix III and appendix IV is the final CO-PO&PSO mapping levels.

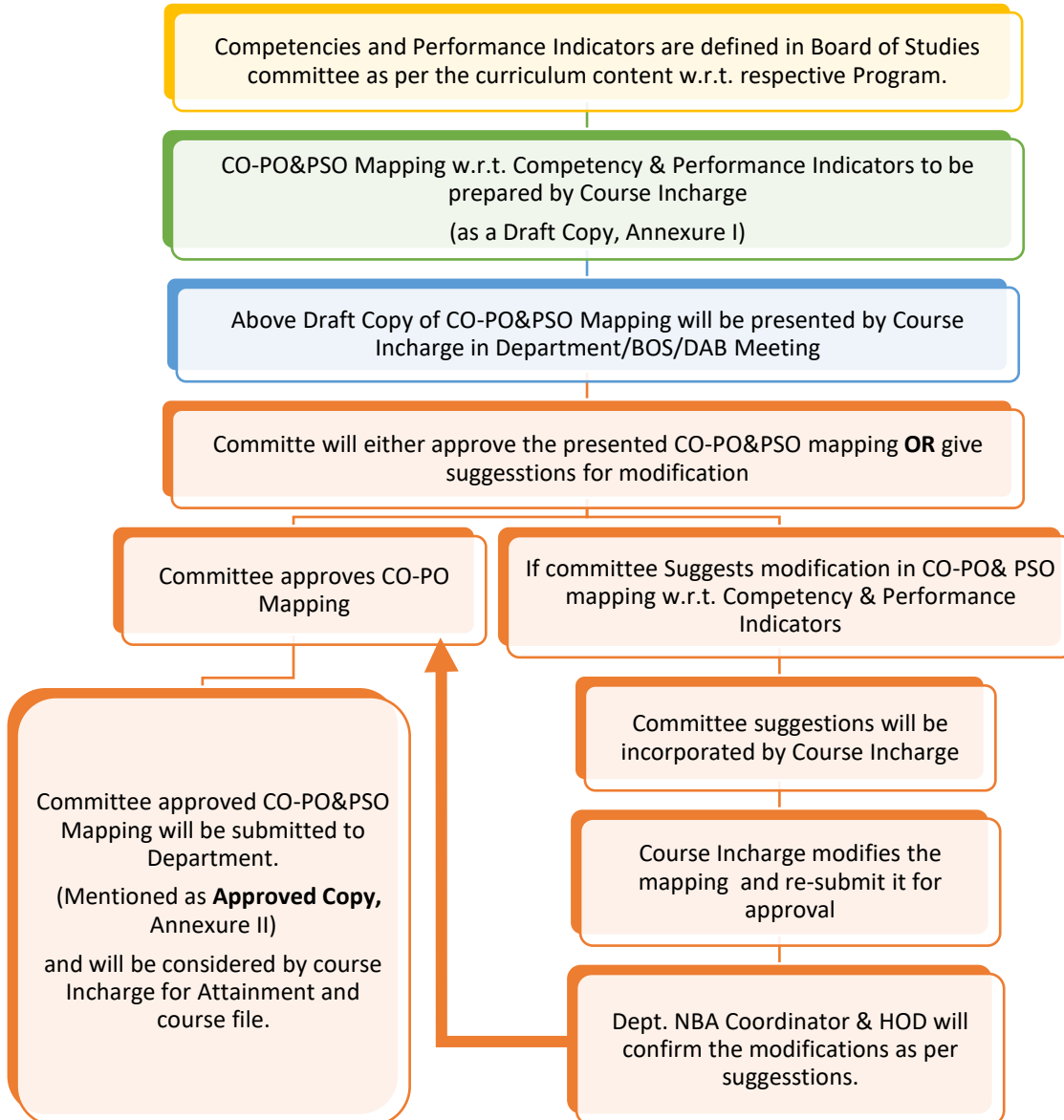


Figure 6 CO-PO Mapping w.r.t. Competency & Performance Indicators (Process Flow Chart)

The tool used for CO-PO Mapping and noting the levels are explained below.

The calculation has been demonstrated in the table below for calculating the CO level for the PO statement; this table gives information on how CO-PO mapping levels have been calculated based on competency and Performance Indicators.

Table 1: Table for CO-PO Mapping and calculating the levels w.r.t. Competency & Performance Indicators.

PO/PSO Statement &No.		Competency		Performance Indicator		Course Outcome Number					
PO_No		C_No		PI_No		CO-a	CO-b	CO-c	CO-d	CO-e	CO-f
<b>PO2: Problem analysis: Identify and analyze well-defined engineering problems using codified standard methods.</b>		1	2.1 Demonstrate an ability to identify and formulate engineering problems.	1	2.1.1 Identify engineering systems, variables, and parameters to solve the problems of a given problem	1	1	1	1	1	1
				2	2.1.2 Identify the mathematical, engineering, and other relevant knowledge that applies.	1	1	1	1	1	-
		2	2.2 Demonstrate an ability to formulate a solution by using standard methods.	3	2.2.1 Identify, assemble and evaluate information and resources.	1	1	1	1	-	-
				4	2.2.2 Identify existing processes/solution methods for solving the problem	1	1	1	-	-	-
		3	2.3 Demonstrate an ability to execute a solution process and analyze results.	5	2.3.1 Apply scientific principles and engineering concepts to formulate the model/s of a system	1	1	-	-	-	-
				6	2.3.2 Produce results through the skillful use of contemporary engineering tools and models	1	1	-	-	-	-
				7	2.3.3 Identify sources of error in the solution process and limitations of the solution.	1	-	-	-	-	-
				8	2.3.4 Interpret desired understanding and conclusions consistent with objectives.	1	-	-	-	-	-
				<b>TPI</b>	<b>MPI</b>	3.0 (100%)	2.3 (75%)	1.5 (50%)	1.1 (37.5%)	0.8 (25%)	0.4 (12.5%)
					<b>Mapping Level</b>	3	3	2	2	1	1

Above table Table 1: Table for CO-PO Mapping and calculating the levels w.r.t. Competency & Performance Indicators, represents Mapping for CO of the course Mechanical Engineering Materials of Polytechnic Mechanical Engineering Program with one PO statement; the table is defined as below.

The column head is as follows,

PO/PSO Statement &No. – is the program outcome and program-specific outcome statement with its serial numbers as PO\_No.

Competency – states competency statement and number C\_No, that learner will demonstrate in line with PO.

Performance Indicator - states the performance indicator statements and their number PI\_No, through which the performance of the student will be assessed in line with respective Competency and PO.

Course Outcome Number – these are the CO statements of one sample course represented here that students will be able to, after delivery of the complete course, and CO-a, CO-b,

CO-c, CO-d, CO-e, CO-f are CO statement numbers (a course with six-course outcome statements).

TPI is the Total Performance Indicator to calculate the mapping level for the respective PO; here, the TPI for PO2 is TPI=8.

MPI is a Mapped Performance Indicator that lets us know CO is mapped at what level to respective PO\_No?

For calculating mapping levels, CO-PO mapping level ranges are defined as,

Level 1 = 00< - 33.33% or 0-1, Level 2 = 33.34 - 66.66% or 1-2, Level 3 = 66.67 – 100% or 2-3 And "-" Indicates No mapping, i.e., course statement does not contribute in any sense to build respective competency and PO skill.

Table 1 shows Total Performance Indicators (TPI) eight (Total TPI=8) defined to assess Competency and PO 2 in Table 1.

*General formulae to understand calculating Mapping Level, Total TPI =8 (for PO2 there are eight Performance Indicators)*

MPI means CO that is mapped to the respective PI.

$$MPI = \frac{\text{Number of PI mapped to CO}}{\text{Total PI (here = 8)}} \times 100$$

The obtained value is in the Percentage.

Now, this Percentage is multiplied by the Highest level of Mapping, i.e., 3

Obtained fraction number is roundup to get the complete number as the final CO-PO Mapping level.

*Sample calculations:*

TPI=8

Number of PI mapped to CO\_b = 6

$$MPI = \frac{6}{8} \times 100 = 75\%$$

Now,

$$75\% \text{ of the Highest level of Mapping, i.e., 3, is,} \\ = 3 \times (75/100) = 2.25$$

This 2.25 is rounded up to 3, and the final CO-PO mapping level will be 3.

Similarly, the remaining calculations are performed as below,

Mapping level of CO\_c

TPI=8

Number of PI mapped to CO\_c = 4

$$MPI = \frac{4}{8} \times 100 = 50\%$$

Now,

$$50\% \text{ of the Highest level of Mapping, i.e., 3, is,} \\ = 3 \times (50/100) = 1.5$$

This 1.5 is rounded to 2, and the final CO-PO mapping level will be 2.

Similarly, Mapping levels for other CO numbers can be calculated.

The final CO-PO mapping levels for each CO statement number are Mapping Levels 3, 3, 2, 2, 1 & 1.

Now it becomes for the charge course to validate and explain the CO-PO mapping levels are based on the competency and performance indicators through which the PO skills can be developed.

This way, a rigid statistical explanation for CO-PO can be demonstrated based on competency and Performance Indicators.

### III. CONCLUSION

The outcome-based education ensures the skills are incorporated into program students. The CO-PO Mapping is the first step that helps measure the contribution from course to PO. This CO-PO Mapping is demonstrated with a case study presented at an engineering institute's Program. The PO statements are given by NBA, while the Program defines the PSO. The program skills to be achieved through the program curriculum can be understood by the competencies that the learner will be able to demonstrate and the performance indicator through which the respective Competency can be assessed and evaluated. These competencies and performance indicators are defined at the program level by brainstorming their curriculum contribution toward cognitive, psychomotor, and affective domain skills developing in line with PO & PSO statements.

The scientific method of justifying the CO-PO mapping level is demonstrated w.r.t to competency & Performance Indicators. There is an opportunity to work to espouse CO-PO Mapping by

defining the competencies and Performance Indicators for the respective level of education Programs.

### IV. REFERENCES

- Dr. A. Kavitha, K. A. (2018). A Empirical Study on CO-PO Assessment & Attainment for NBA Tier-II Engineering Accreditation Towards Empowering the students through Outcome Based Education. *International Journal of Pure and Applied Mathematics*, 118(No. 20), 2615-2624.
- Jayasree, H., & Durga, G. (2018, Oct). An Approach to Establish Correlation of Courses to POs & PSOs . 8(5), 60-71.
- Reddy, B., Karupiah, N., Asif, M., & Ravivarman, S. (2021, January). A Case Study on the Assessment of Program Quality through CO-PO. 34. INDIA: Journal of Engineering Education Transformations.
- REFORMS, A. E. (2018). *Exam Reform Policy*. AICTE. Retrieved from <https://www.aicte-india.org/policies-reforms>
- Resource Material. (2022). Supporting Document. Retrieved from [https://drive.google.com/file/d/1j\\_xCuoK3upaP0tNIAumzSRZuAEB1rp5/view?usp=share\\_link](https://drive.google.com/file/d/1j_xCuoK3upaP0tNIAumzSRZuAEB1rp5/view?usp=share_link)
- Spady, W. G. (1993). *Outcome-Based Education*. ACSA report no 5 . Belconnen: Australian .
- Yuet Yen Wong, Y. S. (2015). Practical Tips to Facilitate CO:PO Mapping and Documentation. *S.F. Tang, L. Logonnathan (eds.), Taylor's 7th Teaching and Learning* . Business Media Singapore: Springer Science. doi:DOI 10.1007/978-981-287-399-6\_39

### V. ACKNOWLEDGMENT

This paper work is supported by the guidance of our colleagues and faculty mentors from our Institute. Authors would like to acknowledge the support and responses provide by the institutes and best practices in the Rajarambapu Institute of Technology.

### VI. ABBREVIATIONS

ABB	Full Form
CO	Course Outcome
PO	Program Outcome
PSO	Program Specific Outcomes
CO-PO	Course Outcome - Program Outcome
OBE	Outcome Based Education
PI	Performance Indicators
BOS	Board of Studies
PAQIC	Program Assessment and Quality Improvement Committee
DAB	Department Advisory Board
BOS	Board of Studies
TPI	Total Performance Indicators
MPI	Mapped Performance Indicators